VISUALIZING THE IMPACTS OF SUBMARINE CABLE BREAKS

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Abstract: When major submarine cables fail, the impacts are immediate and widespread. However, no one involved knows the full story of the impacts on Internet connectivity. This talk will review several major recent submarine cable outages and their impact on Internet operations. Surprisingly, cable failures can even improve latencies, as sub-optimal routes are forced out of service and the Internet discovers higher-performing backup paths that were formerly inaccessible.

1. THE IMPACTS OF SUBMARINE CABLE BREAKS

When major submarine cables fail, the impacts are immediate and widespread. However, no one involved knows the full story of the impacts on Internet connectivity. The cable operator will know the location of the break, but not how traffic shifted around the failure, if an alternative route existed. The Internet service providers will see that some of their routes are unavailable, but might not know why or, more importantly, what to do about it. End users might have no information at all.

To get a more complete picture of such incidents, a sophisticated and carefully positioned global monitoring system is required, employing both active and passive real-time measurements. This paper reviews several major recent submarine cable outages and their impact on the Internet, including an example where a cable failure improved latencies, as a sub-optimal route was forced out of service. Finally, cable activations can be as dramatic as cable failures, as shown by the 2013 activation of the ALBA-1 cable between Venezuela and Cuba.

2. TRACEROUTES AS A MEASURE OF PATH AND LATENCY

Traceroute is a computer program that sends out small messages over the Internet to map the routers encountered between the traffic source and destination. In addition to the paths, a traceroute measurement gives some indication of the round trip times (latencies) between the source and each router along the way.

By monitoring the Internet paths over time, we are able to quickly identify changes in those paths and their performance, measuring latencies of Internet traffic to every part of the Internet in every part of the world.

Some of the most dramatic changes in paths and their latencies are observed when submarine cable breaks or activations occur.

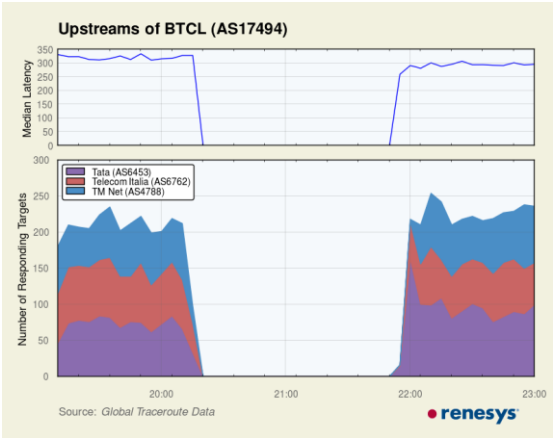
3. SMW4 CABLE BREAKS IMPACT INTERNET IN BANGLADESH

When the sole submarine cable serving a region or country is cut or suffers a failure, the impact to Internet connectivity to this location can be striking.

The Internet of Bangladesh has been connected to the world by a single submarine cable, Sea-Me-We 4 (SMW4), since this 18,800 kilometer-long optical-fiber system made its landing at Cox's Bazar in 2006. However, in the nearly seven years since SMW4's activation, national Internet outages have plagued Bangladesh with some regularity.

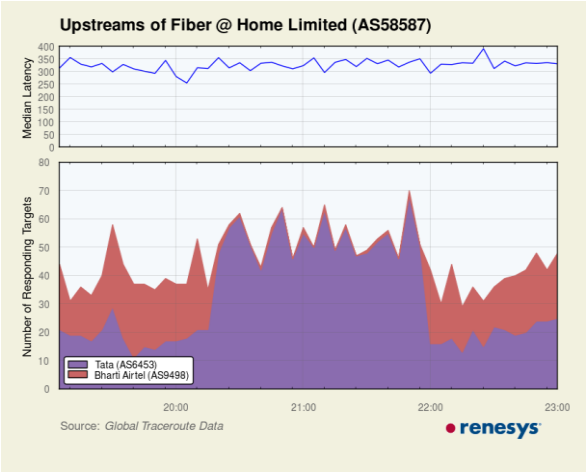
On November 16, 2012, the segment of SMW4 carrying Internet traffic to Bangladesh was taken down for maintenance, cutting Bangladesh off from the world for a few hours. Thus this planned deactivation of a portion of SMW4 had traffic impacts that resembled a submarine cable cut.

Traceroutes from around the world to Bangladesh state telecom, BTCL, failed to complete during this time. The graphic at top right is a stacked plot of how many traceroutes every ten minutes cross into BTCL from one of its International providers: Tata (purple), Telecom Italia (orange), and TM Net (blue).



The November 16, 2012 was notable in one regard, however. For the first time, we observed a single Internet provider in Bangladesh stay online while the country's only connection to the outside world was unavailable. Fiber@Home was able to connect via a new terrestrial route through India.

The graphic below depicts a stacked plot of the counts of measurements reaching Fiber@Home through its providers: Tata (blue) and Bharti Airtel (red). Service from Bharti clearly ceases when the submarine cable is unavailable, but service from Tata increases as Fiber@Home's customers move additional traffic over to Fiber@Home's terrestrial connection to India.



The government of Bangladesh had issued licenses to connect via a land connection to India in January 2012; however, this observation was the first conclusive public evidence that the terrestrial alternative to submarine cable connectivity was active.

4. CUTS CAN SOMETIMES IMPROVE PERFORMANCE

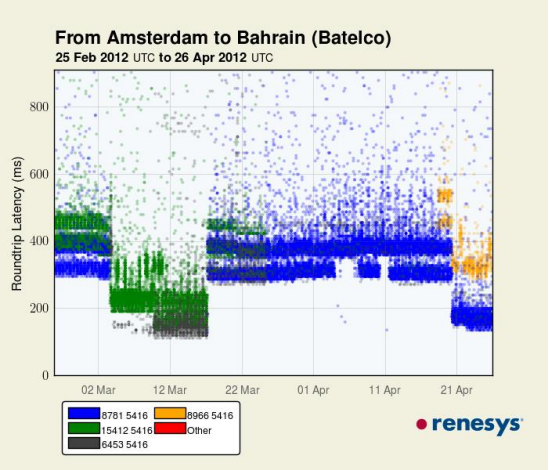
The submarine cable incidents we analyse typically involve a local Internet provider failing over from one international provider to another, sometimes resulting in improved latencies to certain parts of the world. This is due to the fact that every international Internet provider has a different global network footprint and serves different parts of the world differently. Changing to the backup provider will improve latencies to the

backup provider's favored markets, where the primary provider's connectivity is relatively slower.

However, sometimes when latencies improve due to a submarine cable failure, it is because traffic now avoids a suboptimal path. This can be the result of a pre-existing misconfiguration, or because two Internet providers only connect in some faraway city (a phenomenon known as "hairpinning"). In the next example, a submarine cable break actually caused traffic to speed up by avoiding an unnecessarily long path through the Internet.

In March of 2012, the Fiber Optic Gulf (FOG) cable suffered a cable failure that affected Internet providers in the Persian Gulf. While this outage was not publicly announced, we were able to identify which cable had failed based on the set of affected Internet providers in the region.

Between March 3rd and 18th, Internet traffic paths to and through certain providers in the Gulf experienced dramatic shifts in path and latency. One of the more interesting shifts was that of traffic from Amsterdam to Bahraini incumbent, Batelco. The graphic below shows latencies improving in the first half of March, as traceroutes stop entering Batelco's network from Qatar Telecom (blue), and shift to faster paths through Reliance (green) and Tata (gray).



In this case, the high latencies along the Qatar Telecom path were due to Qatar Telecom's network, which was inexplicably sending traffic from Amsterdam across the Atlantic and Pacific oceans to Singapore, and then on to Bahrain. During the cable break this high-latency "wrong way" path was unavailable, and Internet traffic from Amsterdam to Bahrain was forced to take a faster path. The Qatar Telecom misconfiguration was corrected in mid-April.

5. CABLE ACTIVATIONS

Visualizing the changes of Internet traffic paths over time not only reveals the impacts of submarine cable breaks, but can also reveal the activation of new submarine cables. Announcements of new submarine cables often precede actual use for Internet traffic, sometimes by months. An interesting recent example of this is activation of the ALBA-1 submarine cable connecting Cuba to Venezuela.

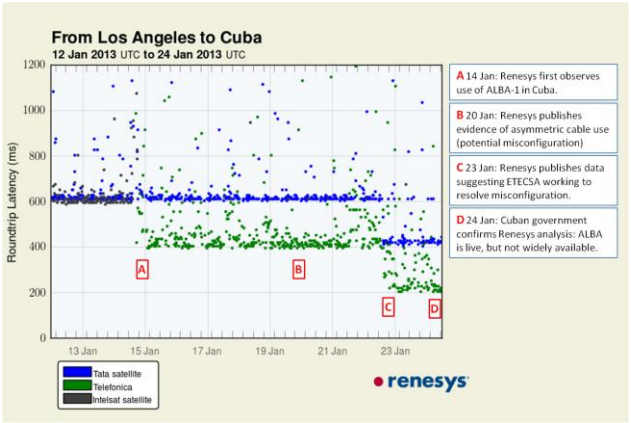
Until very recently, the island nation of Cuba was entirely reliant on slow and expensive satellite Internet service due to lack of a submarine cable connecting the island nation to the global Internet.

In September 2007, the state telecoms of Venezuela and Cuba announced plans to construct a submarine cable, ALBA-1.

The cable was completed by Alcatel-Lucent in February 2011. However, despite the construction of the new cable, there was no noticeable change in Internet service and no mention of the status of the cable by the Cuban government.

On January 20, 2013, we observed a change in BGP routing which suggested that Spanish telecom giant Telefonica had recently begun Internet service to ETECSA, the state telecom of Cuba. By visualizing traceroute measurements into Cuba over time, we were able to identify lower end-to-end latencies that were inconsistent with pure satellite connection. From this, we were able to deduce that the ALBA-1 submarine cable had been activated to carry Internet traffic beginning on January 14, 2013. Four days after we published these results, the Cuban government finally broke its silence on the ALBA-1 cable and confirmed it had recently activated it for testing.

The graphic at top right shows end-to-end latencies from traceroute measurements over time, colored according to the Internet transit providers encountered en-route to ETECSA in Cuba. The blue and gray dots represent the latencies of traceroutes via the satellite service of Tata and Intelsat, while the green dots represent lower-latency traceroutes via Telefonica over the ALBA-1 cable.



6. CONCLUSIONS

Measurements, such as the ones mentioned in this paper, help companies optimize their customers' experience over the Internet, by delivering services more effectively along stable, low-latency paths. However, the data can also be helpful in identifying, describing, and visualizing the dramatic effects of submarine cable breaks and activations.

7. REFERENCES

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